International Journal of Advanced Biochemistry Research

ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2024; 8(2): 98-101
www.biochemjournal.com
Received: 16-12-2023
Accepted: 22-01-2024

Arvind Parmar
Assistant Professor, Department of Agriculture Sciences, IES University, Bhopal, Madhya Pradesh, India

Ram Subhag Singh
Associate Professor, Brahmanand P G College Rath, Hamirpur, Uttar Pradesh, India

Amit Kumar Patel
Assistant Professor, Department of Agriculture Sciences, Dr. CV Raman University, Bhagwanpur, Bihar, India

Akshay Kumar
Department of Agricultural Entomology, University of Agricultural Sciences, Bangalore, Karnataka, India

Awanindra Kumar Tiwari
Krishi Vigyan Kendra Chandrashekhar Azad University of Agriculture & Technology, Kanpur, Uttar Pradesh, India

Chandan Kumar Panigrahi
Department of Entomology Faculty of Agricultural Sciences, Siksha O Anusandhan, Deemed to be University, Bhubaneswar, Odisha, India

Richa Panwar
Department of Genetics & Plant Breeding, SGT University, Gurugram, Haryana, India

Corresponding Author:
Arvind Parmar
Assistant Professor, Department of Agriculture Sciences, IES University, Bhopal, Madhya Pradesh, India

Management of gram pod borer (*Helicoverpa armigera* Hub.) through natural resource based bioagents in chickpea (*Cicer arietinum* L.)

Arvind Parmar, Ram Subhag Singh, Amit Kumar Patel, Akshay Kumar, Awanindra Kumar Tiwari, Chandan Kumar Panigrahi and Richa Panwar

DOI: https://doi.org/10.33545/26174693.2024.v8.i2b.549

Abstract
The field experiment was conducted during *rabi* season 2019-2020 at Agricultural research farm of Bundelkhand University, Jhansi. The chickpea cv. Radhey was grown by following the randomized block design (RBD) with three replications. The six natural resource based bioagents namely HaNPV (*Nuclear polyhedrosis virus*), *Bt.* (*Bacillus thuringiensis), Beauvaria bassiana*, NSKE 5% and their combinations like HaNPV+ *Bt.*, *Beauvarea bassiana* + NSKE5% and HaNPV + *Bt* + *Beauvaria bassiana* were evaluated against *H. armigera* (Hubner). The natural resource based bioagents (alone and their combinations) were sprayed twice (first at flowering and pod formation stage and second after 15 days of first spray). All the natural resource based bioagents were found significantly effective to minimize the population density of gram pod borer larvae. The HaNPV + *Bt.* treatment was found most effective in reducing larval population of *H. armigera*. The maximum efficacy of natura resource based insecticides were observed at 7 days after first and second sprays. The natural resource based bioagents were found significantly effective in reducing the pod damage inflicted by gram pod borer, *H. armigera* and pod damage varied from 3.05 to 5.04%. The HaNPV + *Bt.* was found most effective and had minimum (3.05%) pod damage. While, 14.71% pod damage was observed in untreated control plots. All the natural resource based bioagents were effective to yield more cost benefit ratio in comparision to control treatments, among which two sprays of NPV+*Bt*. reveals maximum cost benefit ratio 1:7.07 and net return (Rs- 106775/ha.) in Bundelkhand agroclimatic zone.

Keywords: Bioagents, population dynamics, *Helicoverpa armigera*, pod damage, chickpea

Introduction
India is the biggest consumer and producer of chickpea in the world and occupies 7.1 million hectares with a production of 5.75 million tones accounting for 30.9% and 39.9% of total pulse area and production, respectively (Kumar *et al.* (2018) [2]. Gram pod borer, *Helicoverpa armigera* (Hubner) is the serious pest of chickpea in Indian Agriculture; it is polyphagous and widely distributed in the world. In India, it has been observed to feed on 181 cultivated and uncultivated species belonging to 45 families. Productivity of gram crop is strongly affected by *Helicoverpa armigera* which damage up to 90-95% crop during favorable weather condition. A single larva of *Helicoverpa armigera* can damage 25-30 pods of gram in its life span. It feeds on tenders shoots and young pods. It makes holes in pods and inserts its half body in to pod and eat the developing seeds (Gautam *et al.* 2018) [2]. Today crop pest have become a major concern for the farmers across the world. Regular and indiscriminate use of chemical insecticides and the misuse of synthetic pesticides on the crop have led to development of insecticide resistance in target pests, pest resurgence, secondary pest outbreaks, loss of bio-diversity, environmental pollution, residual toxicity and occurrence of human health hazards. This has promoted the necessity for seeking natural resource based new, safer, biodegradable insecticides that could be feasible and effective for insect pest management. This has low environmental risk, specificity, safety to non-target organism and low risk of resistance development in insect pests. Entomopathogen are ideal for integrated pest management (IPM) program because they are relatively safe to use and have a narrow spectrum of toxicity against human and animals than chemical insecticides.

Keeping in view he seriousness of the pest, economic importance of this crop and hazardous of insecticides the present study was carried out to evaluate natural resource based bioagents against gram pod borer, *Helicoverpa armigera* (Hubner) in chickpea (*Cicer arietinum* L.).

Materials and Methods

The field experiment was conducted during *rabi* season 2018-2019 at Agricultural Research Farm of Bundelkhand University, Jhansi. The chickpea cv. Radhey was grown by following the randomized block design (RBD) with three replications. The six natural resource based bioagents namely HaNPV (*Nuclear polyhedrosis virus*, Helicide @ 250LE/hac.), *Bt.* (*Bacillus thuringiensis*, Thuricide @ 2ml/l*)*, *Beauvaria bassiana* (Boverin 2ml/l), NSKE 5% and their same dose combinations like HaNPV+ *Bt.*, *Beauvarea bassiana* + NSKE5% and HaNPV + *Bt* + *Beauvaria bassiana* were evaluated against *H. armigera*. The natural resource based bioagents (alone and their combinations) were sprayed twice (first at flowering and pod formation stage and second after 15 days of first spray).

The larval population of *H. armigera* was collected manually in per meter row length at three places that was selected randomly in each plot before spraying of natural resource based bio-pesticides. Thereafter three days after spraying (3DAS), 7 DAS and 10DAS larval population from per meter row length were counted randomly after first and second spraying of natural resource based bioagents (botanical and microbial). At maturity 500 pods were picked up and mixed throughly and among them 100 pods were selected as representative sample. The pod damage by *H. armigera* were seprated with the presence of large circular holes and percentage pod damage was calculated. The population data of gram pod borer larvae were subjected to squre root tranformation ($\sqrt{X + 0.5}$) as reported by Heinrich *et al.* (1981) [5]. However the percentage data of pod damage was converted with arc sine tranformation (Gomez and Gomez 1976) [4]. The tranformed values of population data and percentage pod damage data was used for callulation of critical differences by using randomized block design (RBD). The economics of all the treatments was worked out by considering the price of product, cost of cultivation, cost of natural resource based bioagents (botanical and microbial) and labour charge for two sprays. The cost benefit ratio (CBR) was worked out to cpmpare the economics of natural resource based bioagents (botanical and microbial) treatments by using the following formula-

$$\text{Cost Benefit Ratio (CBR)} = \frac{\text{Net return (Rs/ha.)}}{\text{Total Cost of treatments (Rs/ha)}}$$

Results and Discussion

Efficacy of Natural Resource based bioagents (botanical and microbial) on population of gram pod borer, *Helicoverpa armigera* (Hubner) in chickpea

At 3DAS the two sprays of NPV + *Bt.* combination had maximum efficacy in reducing (1.83 larvae/mrl) the larval population of *H. armigera* (Hubner). The spraying of ecofriendly insecticides (botanical and microbial) significantly reduced larval population of *H. armigera* and varied significantly from untreated control plot (4.00 larvae/mrl). The efficacy of NPV + *Bt.*, HaNPV, NPV + *Bt.* + *Beauvaria bassiana*, *Bt.* and *Beauvaria bassiana* + NSKE 5% were found at par with each other in reducing larval population of *H. armigera*. The spraying of *Beauvaria bassiana* was found least effective (3.25 larvae/mrl) for the management of *H. armigera* population, while untreated control plot had maximum larval infestation (Table-1). The efficacy of ecofriendly management tools on population of *H. armigera* larvae if presented in ascending order are as NPV + Bt > NPV+*Bt.*+ *Beauvaria bassiana* (*Bb*) >NSKE 5% = NPV > *Beauvaria bassiana* (Bb.) > Bt.> *Beauvaria bassiana* + NSKE 5% > control. The present finding is corroborated with the finding of Golvankar *et al.* (2015) [3] who reported microbial insecticides NPV and *Bt.* (alone or in combination) at 7 days after spraying had minimum population of *H. armigera* larvae and lowest chickpea pod damage.

The efficacy of all the ecofriendly insecticides (botanicals and microbial) in reducing the larval population of *H. armigera* (Hubner) was varied significantly from untreated control at 7 DAS. The HaNPV + *Bt.* combination was found most effective (1.17 larva/mrl) for the management of gram pod borer larvae in chickpea (Table-1). The efficacy of HaNPV + *Bt.* was found at par with HaNPV + *Bt.* + *Beauvaria bassiana*, HaNPV, NSKE 5% and *Bt.*, which had 1.50, 1.83, 1.83 and 2.17 larvae/mrl, respectively. Among ecofriendly insecticides the efficacy of *Beauvaria bassiana* was lowest (2.75 larvae/mrl) in reducing the larval population of *H. armigera* in chickpea, while untreated control treatment had maximum (5.33 larvae/mrl) infestation. After second spray at 7 days after spraying (DAS) the larval population of *H. armigera* if arranged in ascending order would be as NPV + Bt > NPV+*Bt.*+ *Beauvaria bassiana* (*Bb*).>NSKE 5% = NPV > *Beauvaria bassiana* (Bb.) > Bt.> *Beauvaria bassiana* + NSKE 5% > control. The two sprays of ecofriendly natural resource based insecticides (first at flowering and pod formation stage and second after 15 days of first spray) was found most effective in reducing the larval population of *H. armigera*. The similar reports made earlier by Srivastava *et al.* (2017) [12], that said sequential spraying of insecticides at flowering and podding stage were most effective in chickpea.

All the natural resource based bioagents (botanical and microbial) were found significantly effective against *H. armigera* (Hubner) in chickpea at 10 DAS as compare to untreated control which had 5.67 larvae/mrl. The plots treated with HaNPV + *Bt.* was found most effective in reducing the larval population (1.50 larvae/mrl) of *H. armigera*. It was found at par with HaNPV, NPV + *Bt.* + *Beauvaria bassiana*, NSKE 5% and *Bt.* in efficacy against *H. armigera* (Hubner) larvae (Table-1). Among natural resource based bioagents (botanical and microbial) *Beauvaria bassiana* were found least effective and observed 3.42 larvae/mrl infestation intensity of *H. armigera***.** At 10 DAS of ecofriendly insecticides (botanical and microbial) the larval population if arranged in descending order would be as NPV + Bt > NPV+*Bt.*+ *Beauvaria bassiana* (*Bb*)=NSKE 5% > NPV > Bt.> *Beauvaria bassiana* + NSKE 5% > *Beauvaria bassiana* (Bb.) > control. At 10 DAS the combination of all the microbial insecticides (NPV+*Bt.*+ *Beauvaria bassiana*) was equally effective as NSKE 5%.

Average data of larval population of both the sprays at different days after spraying indicated that all the ecofriendly insecticidal treatments were significantly effective in reducing the larval population of gram pod borer as compared to untreated plots (5.00 larvae/mrl) which had maximum infestation. The combination of NPV+*Bt.* treatment proved to be most effective in managing the population dynamics of gram pod borer (1.50 larvae/mrl)) over rest of the treatments. Whereas, the efficacy of rest of the ecofriendly tools of pest management in reducing the larval population of *H. armigera* was shown in descending order as NPV+ *Bt.* +*Beauvaria bassiana* (1.98 larvae/mrl), NSKE and HaNPV (2.08 larvae/mrl), *Bt.* (2.39 larvae/mrl), *Beauvaria bassiana* + NSKE (2.75 larvae/mrl), and *Beauvaria bessiana* (3.14 larvae/mrl) (Table 1). The similar report made earlier by Singh and Ali (2005) [10] who observed *Bt.* and HaNPV caused 80% and 75% mortality in *H. armigera* (Hubner) while Singh and Yadav (2007) [11] observed that after 7 days spray of *Bt.* (halt) and HaNPV were most effective against *H. armigera*. Ramesh *et al.* (2017) [8] recommended that NSKE 5% and HaNPV significantly suppress the larval population of *Helicoverpa armigera* (Hubner).

Although, the larval population of *H. armigera* varied from 3.17 to 4.50 larvae/mrl in all experimental plots at one day before spray of botanical and microbial insecticides. The population data one day before application showed normal distribution of *H. armigera* (Hubner) larvae.

Efficacy of natural resource based bioagents (botanical and microbial) on pod damage by *Helicoverpa armigera* in chickpea

The pod damage among all the natural resource based bioagents (botanical and microbial) treated plots showed non-significant differences among each other but varied significantly with untreated control plot. While two spray of NPV + *Bt.* combination had lowest (3.05%) pod damage. It was followed by HaNPV + *Bt.*+ *Beauverea bassiana*, Ha NPV, NSKE 5%, *Bt.*, *Beauveria bassiana* +NSKE 5% and *Beauverea bassiana* which had 3.34%, 3.36%, 3.53%, 3.95%, 4.13%, 5.04% efficacy in reducing the pod damage by *H. armigera* (Hubner) in chickpea, respectively, (Table- 1). The pod damage among HaNPV + *Bt*, HaNPV+*Bt.*+ *Beauvaria bassiana*, NSKE5% and HaNPV treated plots were found statistically at par with each other. The untreated plot (natural infestation) showed maximum pod damage (14.71%) inflicted by *H. armigera* (Hubner). The pod damage among various botanical and microbial insecticides treated plots varied from 3.05% to 5.04% which had significantly variation from untreated control plots (14.71%). The efficacy of ecofriendly management tools in reducing the percent pod damage inflicted by *H. armigera* larvae if presented in descending order would be as NPV + *Bt* > NPV+*Bt.*+ *Beauvaria bassiana* (*Bb*) > NPV >NSKE 5% > *Bt.*> *Beauvaria bassiana* + NSKE 5% > *Beauvaria bassiana* (Bb.) > control. The present investigation is corroborated with the finding of Kumar *et al.* (2013) [6] reported HaNPV was effective as compare to novel insecticides and control in Bundelkhand region 14.71% pod was damage if no control major adopted this is corroborated with the findings of Singh *et al.* (2015) [9] who reported 15.3% chickpea crop losses in Uttar Pradesh by *Helicoverpa armigera* (Hubner).

Economics of natural resource based bioagents (botanical and microbial) in chickpea

The economics of all the natural resource based bioagents (botanical and microbial) in treated plots were observed higher than untreated control plot. The plot treated with two spray of NPV+*Bt.* (First at flowering and pod formation stage and second after 15 days of first spray) had maximum cost benefit ratio (1:7.07). It was followed by NPV+*Bt.*+*Bb.* (1:7.04), NPV (1:6.71) and NSKE (1:6.63). The NPV+*Bt.* treatment were found most effective in point of monitory gains (Rs-106775) (Table- 2). The findings are corroborated with the earlier work done by Deshmukh *et al.* (2010) [1] that reported all the insecticidal treatments produces maximum cost benefit ratio comparing to control. That varies from 1:1.51 to 1:7.08. The cost benefit ratio of botanicals and microbial based insecticides in chickpea was higher due to the low price of biorational insecticides.

Table 1: Efficacy of natural resource based bioagents (botanical and microbial) on the population of *Helicoverpa armigera* (Hubner) (pooled of first and second sprays)

S. No.	Treatment Details	Number of larvae/meter row length after second spray					Pod Damage (%)
		1 DBS	3 DAS	7 DAS	10 DAS	Mean	
1.	Control (Without spray)	3.00 (1.99)	3.67 (2.16)	5.00 (2.44)	5.33 (2.52)	4.67 (2.37)	14.71 (3.89)
2.	Nuclear Polyhedrosis Virus (NPV)	3.67 (2.14)	2.17 (1.76)	1.67 (1.63)	2.00 (1.72)	1.95 (1.70)	3.36 (2.08)
3.	*Bacillus thuringenesis (Bt.)*	3.00 (2.00)	2.33 (1.82)	2.00 (1.72)	2.33 (1.82)	2.22 (1.79)	3.95 (2.23)
4.	*Beauvaria bassiana*	3.33 (2.06)	3.17 (2.04)	2.50 (1.87)	3.17 (2.04)	2.95 (1.98)	5.04 (2.46)
5.	Neem Seed Kernel Extract (NSKE 5%)	4.33 (2.28)	2.17 (1.76)	1.67 (1.63)	2.00 (1.72)	1.95 (1.70)	3.53 (2.13)
6.	Nuclear Polyhedrosis Virus + *Bacillus thuringenesis* (NPV+*Bt.)*	4.00 (2.23)	1.67 (1.63)	1.00 (1.41)	1.33 (1.52)	1.33 (1.52)	3.05 (2.01)
7.	*Beauvaria bessiana* + NSKE	4.33 (2.28)	2.67 (1.90)	2.33 (1.82)	2.83 (1.96)	2.61 (1.89)	4.13 (2.27)
8.	NPV+*Bt.*+ *Beauvaria bassiana*	3.00 (1.99)	2.18 (1.77)	1.33 (1.52)	2.00 (1.72)	1.84 (1.67)	3.34 (2.08)
	C.D at 5% level of significance	NS	0.37	0.34	0.38	-	0.19

Figures of population in parentheses are $\sqrt{x+0.5}$ transformed values, Figures of pod damage in parentheses are Arc Sin transformed values, DBS – Days before spray, DAS – Days after spray

Table 2: Economics of natural resource based bioagents (botanical and microbial) against gram pod borer in chickpea-

S. No.	Treatments	Biorational insecticides Cost /plot (two spray) (Rs)	Total cost of treatments (Rs)	Yield of chickpea Kg/ha.	Gross income (Rs)	Net income (Rs)	CBR
1.	NPV	1200	2400	2390	116512	101412	1:6.71
2.	*Bt*.	1600	2800	2279	111101	96001	1:6.35
3.	*Bb*	1100	2300	2063	100571	85471	1:5.66
4.	NSKE	800	2000	2365	115293	100193	1:6.63
5.	NPV+*Bt*.	2800	4000	2500	121875	106775	1:7.07
6.	*Bb*.+NSKE	1900	3100	2346	114367	99267	1:6.57
7.	NPV+*Bt*.+*Bb*.	3900	5100	2492	121485	106385	1:7.04
8.	Control	-	-	1804	87945	72845	1:4.82

Labour charge-Rs.-1200/two spray, MSP of chickpea- Rs. 48.75/kg, Cost of cultivation- Rs. 12700/ha

Conclusion

Gram pod borer (*Helicoverpa armigera* (Hubner) was observed as a major pest of chickpea during 2019-20 in Jhansi agroclimatic region of Uttar Pradesh. The two sprays of HaNPV, *Bt*., NSKE 5% and *Beauvaria bassiana* (first at flowering and podding stage and second after 15 days of first spray) and their combinations were significantly effective in reducing the population density of *H. armigera* (Hubner) larvae at /below economic threshold level. Among which the two sprays of HaNPV + *Bt.* was found best and showed minimum population density of *H. armigera* (Hubner) larvae and also proved as best effective treatments for minimum (3.05%) pod damage, although, all the biorational insecticides were significantly effective in reducing the pod damage as compare to untreated plot (14.71%). The plots treated with two spray of NPV + *Bt.* yielded maximum CBR (1:7.07) and net return (Rs-106775/ha.). Hence, two sprays of HaNPV @ 250 LE/ha + *Bt* @ 1.2 liter/ha was found most effective for managing pest population, produced maximum CBR, conserving ecosystem and maintaining or enhancing the quality of environment.

References

1. Deshmukh SG, Sureja BV, Jethva DM, Chatar VP. Field efficacy of different insecticides against *Helicoverpa armigera* (Hubner) infesting chickpea. Legume Res. 2010;33(4):269-273.
2. Gautam MP, Chandra U, Singh SN, Yadav SK, Giri SK. Studies on efficacy of botanicals against *Helicoverpa armigera* (Hub.) on chickpea (*Cicer arietinum* L.). Int J Curr Microbiol Appl Sci. 2018;Special Issue-7:612-618.
3. Golvankar GM, Desai VS, Dhobe NS. Management of chickpea pod borer (*Helicoverpa armigera* Hub.) by using microbial pesticides and botanicals. Trends Biosci. 2015;8(4):887-890.
4. Gomez KA, Gomez AA. Statistical Procedures for Agricultural Research. John Wiley & Sons, Inc. New York; c1976.
5. Heinrichs EA, Chelliah S, Valencia SC, Arceo MB, Fabellar LT, Aquino GB, *et al*. Statistical analysis of insect population and plant damage. Manual for Testing Insecticides on Rice. IRRI, Manila, Philippines; c1981. p. 73-80.
6. Kumar P, Bansal A, Kumar S. Field evaluation or comparative efficacy of synthetic and bio-pesticides formulations against gram pod borer in chickpea. Prog Res. 2013;8(Special):914-916.
7. Kumar L, Bisht RS, Singh H, Kumar A, Pandey N, Kumar M. Bioefficacy and economics of some newer insecticides and bio-pesticides against *Helicoverpa armigera* (Hubner) on chickpea (*Cicer arietinum* L.) crop. J Pharmacogn Phytochem. 2018;SPI:1739-1744.
8. Ramesh G, Rao PN. Evaluation of pest management practices in chickpea ecosystem for the control of sucking pests and pod-borer. Int. J Appl. Biol Pharm Tech. 2017;8(1):10.21276.
9. Singh P, Singh R, Kumar S, Kumar V, Kumar S. Bio-efficacy of certain new insecticides against larval population of gram pod borer, (*Helicoverpa armigera* Hubner) in chickpea. Int. Q J Environ Sci. 2015;7(11):315-318.
10. Singh S, Ali M. Efficacy of biopesticides in the management of *Helicoverpa armigera* (Hubner) in chickpea. Ann Plant Prot Sci. 2005;13(1):94-96.
11. Singh S, Yadav SK. Comparative efficacy of insecticides, bio-pesticides, and neem formulations against *Helicoverpa armigera* (Hubner) on chickpea. Ann Plant Prot Sci. 2007;15(2):299-302.
12. Srivastava D, Kumar A, Singh PC, Srivastava S, Srivastava S, Tiwari A, *et al*. Studies on microbial metabolites as eco-friendly insecticides against *Helicoverpa armigera*. Int. J Curr Microbiol. Appl. Sci. 2017;6(12):3828-3832.